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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Andrea Urban

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EXAMINER

AHMED, SHAMIM

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/676,295	Applicant(s) URBAN ET AL.	
	Examiner Shamim Ahmed	Art Unit 1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 May 2009.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-8 and 10-21 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-8, 10-21 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Response to Arguments

1. Applicant's request for reconsideration of the finality of the rejection of the last Office action is persuasive and, therefore, the finality of that action is withdrawn.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 1-3 and 8,10 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

4. Regarding claim 1, the phrase "injecting a high-frequency power into the etching body" renders the claim indefinite because it is unclear whether the power is directly injected through capacitively coupled with the etching body or inductively through a plasma via inductive coupling.

5. Regarding claim 1, line 6, the phrase "at least approximately ambipolar plasma being present" renders the claim indefinite because it is unclear because the term "approximately" is not positively reciting the presence of the ambipolar plasma.

6. Regarding claim 8, the phrase "the plasma is pulsed at a frequency of 1 KHz to 10KHz" renders the claim indefinite because it is unclear whether this frequency is different than that of the frequency of at least 500 Hz as recited in claim 7.

7. Claim 10 recites the limitation "the low-frequency pulsing" in line 3. There is insufficient antecedent basis for this limitation in the claim.

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8. Regarding claim 10, the phrase "fixed phase ratio" renders the claim indefinite because it is unclear what is the phase ratio and in what relation or relative to what?

9. As regards to claim 10, the use of phrase of "substrate pulse" is not clear whether the substrate pulse means pulsing the substrate bias frequency or the substrate is pulsed by it self?

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

11. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

12. Claims 1-3, 7-8 and 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (6,143,476) as supported by Ohtake et al ("Charge-free etching using positive and negative ions --- low-frequency bias") in view of Aota et al (2003/0070759).

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Ye et al teach a plasma etching process for manufacturing semiconductor device including the step of generating plasma through a substrate electrode and high - frequency (RF) power is supplied to the substrate electrode via a matching net-work (col.7, lines 61-67). Ye et al teach the term "plasma" which refers to a partially ionized gas containing an equal number of positive and negative charges or ions (col.7, lines 21-25). Ye et al may not explicitly teach that the generated **plasma** obviously in an ambipolar in nature as supported by Ohtake et al (see 1st paragraph at page 2416), wherein Ohtaka et al teach ambipolar means the presence of both the positive and negative ions or charges.

Ye et al also teach pulsing the power to the device that produces the ions species such as plasma and such pulsing can be provided internally or externally or may be pulsing the ion energy by pulsing the substrate biasing (col.12, lines 60-col.13, lines 1-7).

It is noted that pulsing the plasma generator reads on the limitation of refraining from injecting the high-frequency into the substrate---- in response to an at least approximately ambipolar plasma being present .

Ye et al may not explicitly teach the high-frequency power is modulated or pulsed with low frequency and during such processing, refraining from injecting the high-frequency power into the etching body via the substrate electrode.

However, Aota et al teach an apparatus that can be used during etching or deposition process with improvement (paragraphs 0046 and 0103), wherein the high frequency power (paragraph 0052) is modulated with low-frequency, wherein the

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modulation frequency is in the range of **50 Hz to 100 KHz** for suppressing by-product during plasma processing (paragraphs 0045 and 0050) in order to high quality, high-speed plasma processing (paragraph 0015).

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to employ Aota et al's teaching into Ye et al's teaching for achieving a high-quality plasma processing as suggested by Aota et al.

13. Claims 4-6 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (6,143,476) as supported by Ohtake et al ("Charge-free etching using positive and negative ions --- low-frequency bias") in view of Aota et al (2003/0070759) as applied above, and further in view of Ise et al (6,218,196) as supported by Hasimoto et al (5,779,925).

Modified Ye et al discusses above except the first pulsing and the low-frequency are performed at the same frequency (as of claim 10) or existing a fixed integral phase ratio between the pulses (as of claim 4).

However, Ise et al teaches a high-frequency power is modulated with low-frequency, wherein the modulation duty ratio of a pulse waveform is fixed at the optimum value of 50%. Ise et al teach that the pulse frequency range of 1 Hz to 50 kHz as long as the duty ratio falls at least within a range of 20% to 75% (col.2, lines 37-45, col.3, lines 7-10 and col.5, lines 62-67) and such arrangement reduces the reaction product accumulation on the surface to be etched (col.5, lines 11-20).

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As the claims do not limit that the first and the second or the low-frequency pulses are different from each other, it is considered that the low frequency pulse falls within the claimed range and expected to have the similar result.

Furthermore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to use the same frequency for pulsing the plasma and the substrate bias frequency for reducing the processing cost such as a single pulse generator can provide the same pulse frequency as supported by Hashimoto et al (5,779,925).

Hashimoto et al teach a RF signal having a wave form similar to the RF output wave form is picked up from the RF bias power and the pulse generator generates a pulse train having the same repetition period as the inputted RF signal and a desired on-period synchronous with a desired phase (col.10, lines 7-15).

As to claim 4, as Hashimoto et al appears to teach both the pulse wave form are similar and therefore, a fixed integral ratio exist between the pulse train.

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to employ Ise et al and Hashimoto et al's teaching into Ye et al's process for reducing the reaction product accumulation on the etched substrate as taught by Ise et al.

14. Claims 11-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (6,143,476) as supported by Ohtake et al ("Charge-free etching using positive and negative ions --- low-frequency bias") in view of Koshimizu (5,290,383).

Modified Ye et al discusses above in the paragraph 10 but fail to teach adding an inert gas in the plasma.

However, in a controlled plasma etching process of silicon substrate, Koshimizu teaches the addition of inert gas into the plasma in order to stabilize the plasma (col.14, lines 29-41).

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to combine Koshimizu's teaching into Modified Ye et al's process for stabilizing the plasma as taught by Koshimizu.

15. Claims 16-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (6,143,476) as supported by Ohtake et al ("Charge-free etching using positive and negative ions --- low-frequency bias") in view of Sumiya et al (2002/0114897).

Ye et al discusses above in the paragraph 10 but fail to teach synchronizing the modulation and the low-frequency modulation with one another.

However, Sumiya et al teach the time-modulated bias power, the pulse discharging period is synchronized with the time-modulated bias power and the on period of the pulsed discharge is also synchronized with the on period of the time-modulated bias power. This makes it possible to lower the voltage appearing on the gate oxide film. In the off time of the pulsed discharge, as to the continuous bias, the ions in the plasma being attenuated are charged onto the substrate after the pulse-off period, while as to the time-modulated bias power, no function is provided of charging the ions in the plasma into the substrate after the pulsed discharge. As shown in FIG. 4, it is considered

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that the electron/ion saturated current ratio is quickly decreased in the sparse portion on the surface of the substrate [0049].

[0052] In the case of applying the high frequency bias to the substrate having a portion to be etched of the sparse patterns for performing the plasma process, by adjusting the pulse repetitive frequency and the duty ratio and increasing the ratio of the time .tau. when the electron/ion saturated current ratio is 1 per one pulse period or the ratio of the time when the electron/ion saturated current ratio is 1/10 or less per one pulse period, at which ratio of 1/10 the difference of the electron/ion saturated current ratio between the spare and the dense portions of the patterns becomes small, it is possible to lower the charging damage. Further, by combining the time-modulated bias with the pulsed discharge and synchronizing both with each other, it is possible to reduce the voltage occurring on the gate oxide film, thereby reducing the charging damage and making it possible to perform the highly accurate etching

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to combine Sumiya et al's teaching into Ye et al's process for reducing charging damage and for improved etching precision as taught by Sumiya et al.

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16. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable Ye et al (6,143,476) as supported by Ohtake et al ("Charge-free etching using positive and negative ions --- low-frequency bias") in view of Dockrey (4,799,991).

Ye et al discusses above in the paragraph 10 and also teach the etchant gas comprises Cl_2 , HCl , etc. (col.13, lines 35-38) but fail to teach that the under etching is performed using highly oxidizing fluorine compound includes ClF_3 .

However, in a process of silicon etching, Dockrey teaches the use of HCl and ClF_3 can be used as an efficient etchant for silicon (see col.3, lines 35-40 and claim 2).

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to combine Dockrey's teaching into Ye et al's process because both HCl and ClF_3 are functionally equivalent as taught by Dockrey.

Conclusion

17. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Winniczek et al (6,093,332) and Kofuji et al (6,231,777) teach a high frequency power is pulsing with low frequency and Samukawa (5,827,435) teaches the introduction of pulsed high-frequency and substrate bias is pulsed with low frequency of 400 to 600 KHz.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shamim Ahmed whose telephone number is (571) 272-1457. The examiner can normally be reached on Tu-Fri (6:00-2:30) Every Monday Off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G. Norton can be reached on (571) 272-1465. The fax phone

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number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Shamim Ahmed
Primary Examiner
Art Unit 1792

SA
June 2, 2009

/Shamim Ahmed/
Primary Examiner, Art Unit 1792